

Waterborne Gastrointestinal Illness at a Ski Resort

—Isolation of *Yersinia enterocolitica* From Drinking Water—

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WATERBORNE DISEASE CONTINUES to occur in this country despite the widespread availability of public purified water supplies and sewage treatment (1). Since the early 1950s the annual number of reported outbreaks has doubled, and in 1973, 24 outbreaks (involving 1,720 people) were reported to the Center for Disease Control (2). Thirteen were ascribed to sewage poisoning (a syndrome of nausea, vomiting, diarrhea, and fever for which no specific etiological agent was found). Sewage poisoning has variously been ascribed to enteropathogenic *Escherichia coli*, unidentified viral agents, and chemical toxins. Recently, *Yersinia enterocolitica* was incriminated as the cause of gastrointestinal illness in two large outbreaks in Japan (3), but the mode of transmission was not determined. In an epidemic in Montana in 1975, *Y. enterocolitica* was isolated from the water.

Outbreak in Montana

On January 14, 1975, an official of the Minnesota State Department of Health called the Montana State Epidemiologist's office to report that approximately 30 of 50 Minnesotans who had just

returned from a ski resort in Montana had experienced a gastrointestinal illness in which nausea, vomiting, diarrhea, and abdominal cramps were the predominant symptoms. That same day a city sanitarian of Great Falls, Mont., reported to the Montana State Epidemiologist that 30 of 50 residents had had similar symptoms after skiing at the same resort.

Epidemiologists from the Montana State Department of Health

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and the Enteric Diseases Branch, Bacterial Diseases Division, Bureau of Epidemiology, Center for Disease Control, went to the resort to investigate the outbreak.

Investigation

Eighty-six employees of the resort were surveyed January 16, 1975; 65 (76 percent) had experienced a gastrointestinal illness since December 6, 1974. No common source of infection except possibly water was identified.

Special Pathogens in the same branch, and Ms. Highsmith is a microbiologist, Hospital Infections Laboratory Section. Dr. Skaliy is chief and Mr. Wood, assistant chief, Microbiologic Control Branch. Mr. Stoopler, a medical student at the time of the study, was an epidemiological aide in the Office of the Director, Cancer and Birth Defects Division. Frances Porcher, chief of Editorial and Graphic Services, Bureau of Epidemiology, provided editorial assistance.

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Water samples obtained from the resort area on January 14, 15, and 16 yielded from 1 coliform to more than 16 coliforms per 100 ml. All previous water samples—since March 1972—had contained no coliforms; the most recent testing had been in November 1974. On January 17, the 17,000-gallon suction well and the 500,000-gallon storage tank were chlorinated to a total residual of 1 ppm, and no more cases of gastrointestinal illness occurred thereafter.

To determine the magnitude and source of the epidemic, the investigators designed a questionnaire to be administered by telephone to guests who were registered at the resort during the period in which the resort employees had been ill (December 6, 1974, through January 17, 1975).

Questionnaire Survey

Aware that we would not be able to question all who had been at the ski lodge, we chose a group that represented approximately 10 percent of the estimated 1,800 guests who had stayed at the lodge during this period. We chose this sample size because it would allow us to detect a statistically significant difference ($P=0.05$) between the attack rates for water drinkers and nonwater drinkers if the true attack rates were 50 percent for water drinkers and if 10 percent of the guests were nonwater drinkers.

The names of 196 persons were randomly selected from a list of approximately 600 Montana residents who had registered at the lodge between December 5, 1974, and January 17, 1975. Among the randomly selected registrants was a group of 37 snow surveyors who had attended a meeting at the resort. These registrants, their lodge roommates, and members of their families who had visited the

resort—a total of 426 persons—were selected for tabulation as to age, sex, arrival and departure times, room number, date and time of onset of gastrointestinal illness, symptoms and duration of such illness, physician consultation or hospitalization, average daily water consumption at home and at the resort, iced-beverage consumption, and places of consumption of food and water at the resort.

We defined gastrointestinal illness as one in which, after arrival at the resort or within 7 days after departure, the guest experienced at least one of the following symptoms: nausea, vomiting, diarrhea, and abdominal cramps. Information was also obtained on members of the registrants' families who had not visited the resort. All 37 snow surveyors were also asked for information on the specific foods and beverages they had consumed at each meal at the resort.

Epidemiologic Results

We were able to get information from 170 (87 percent) of the 196 lodge registrants selected for questioning and found that only one case of gastrointestinal illness had occurred before December 27. This date was thus considered the beginning of the epidemic. No

cases occurred after December 17, the day the water was chlorinated. We based our analysis therefore on the 317 guests at the lodge between December 23 (allowance being made for a 3-day incubation period) and January 17. Among these 317 people—registrants, their roommates, and family members—129 (41 percent) had been ill (fig. 1).

The daily occupancy of the lodge roughly paralleled the epidemic curve, but the attack rate rose progressively from week to week during the epidemic period (fig. 2).

The frequency of symptoms for the 129 patients was as follows:

Symptom	Percent with symptom
Nausea	81
Fatigue	72
Diarrhea	71
Abdominal cramps	62
Vomiting	61
Muscle aches	49
Headache	41
Fever	36
Runny nose	18

The median interval between arrival at the resort and onset of illness was 57 hours, and the median duration of illness was 18 hours. No patients in the sample were hospitalized, and only 5 percent (7 of 129 persons) consulted a physician. The median age of

Figure 1. Gastrointestinal illness in a sample of 317 ski lodge guests in Montana, by date of onset, Dec. 23, 1974–Jan. 25, 1975

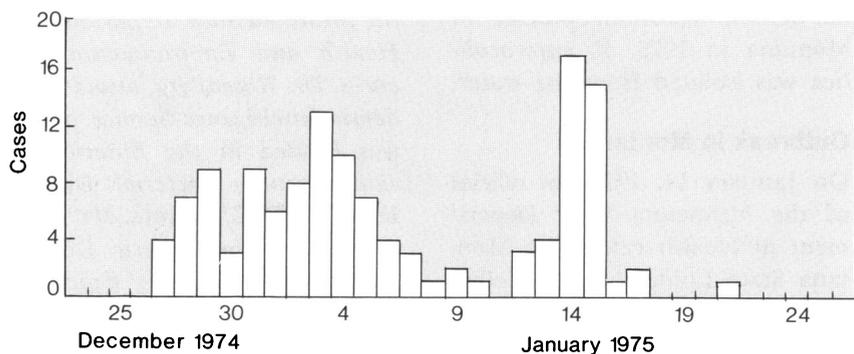
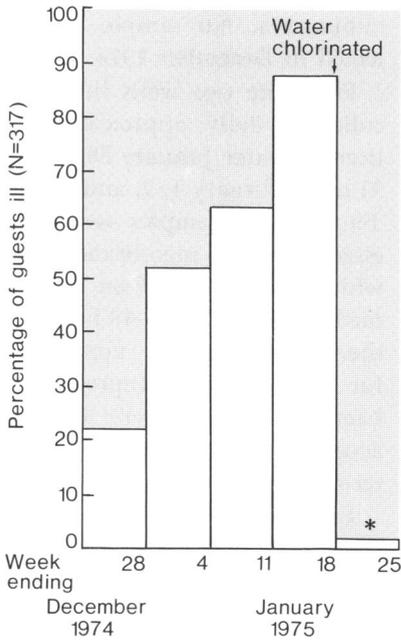


Figure 2. Percentage of sample of ski lodge guests with gastrointestinal illness, by week, Dec. 23, 1974-Jan. 25, 1975



* 1 guest arrived Jan. 17, 1975.

patients was 32 years. Age-specific attack rates showed no predilection for illness in any age group. The attack rate for males (94 cases per 172 persons, or 48 percent) was significantly higher ($P=0.005$) than the rate for females (45 cases per 142 persons, or 31 percent), but this difference was not significant when the predominantly male snow survey group (37 people) was excluded.

There was a significant association between water drinking and gastrointestinal illness ($P=0.0001$) (fig. 3), but no association was found between illness and room location or where the guests ate and drank.

The secondary attack rate for family members who did not visit the ski resort, calculated according to the schema illustrated in fig. 4, was 15 percent, but this attack rate was not significantly different from that observed for families in which no illness oc-

curred among visitors to the ski resort (the control group).

When data on the snow survey subgroup were analyzed separately, the group had a higher attack rate (89 percent) than other guests, but otherwise the illness appeared to be similar to that of the guests as a whole. Thirty-four

Figure 3. Gastrointestinal illness attack rates for sample of ski lodge guests, by water consumption, Dec. 23, 1974-Jan. 17, 1975

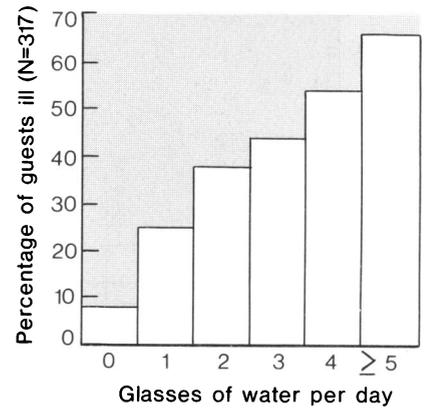


Figure 4. Secondary attack rates among families of persons who visited ski lodge between Dec. 23, 1974 and Jan. 17, 1975

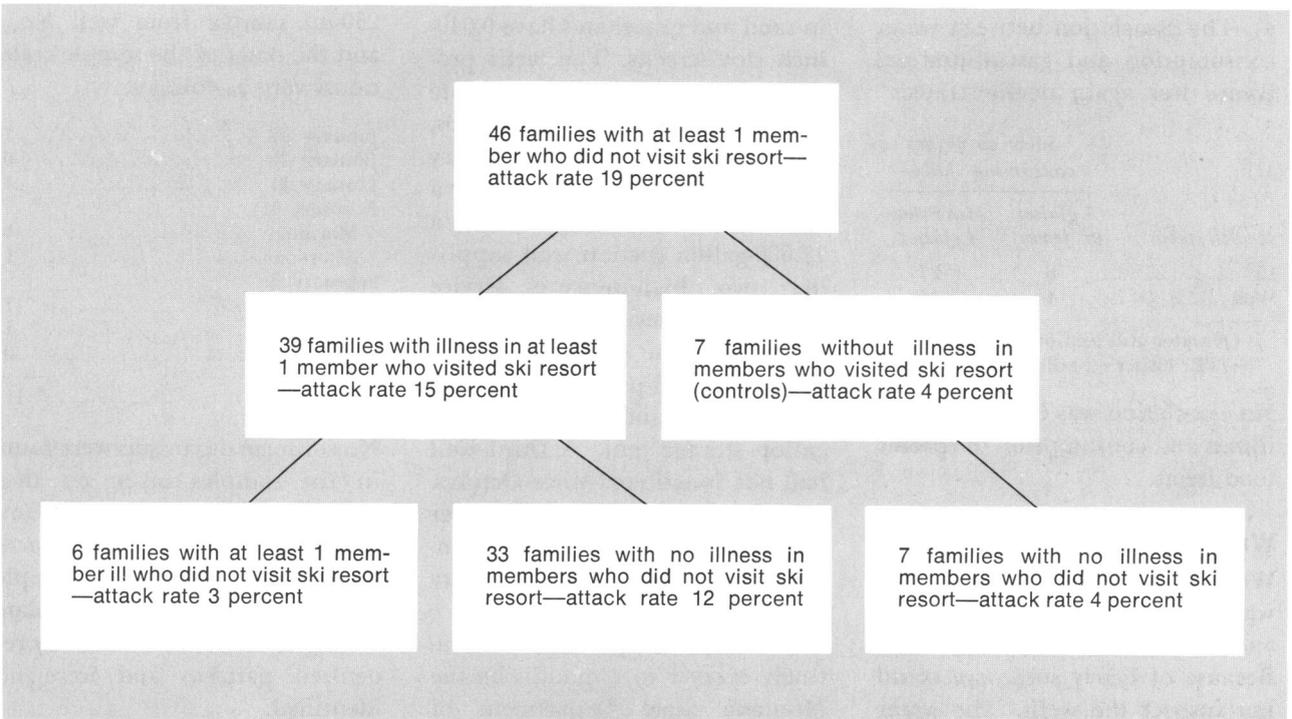
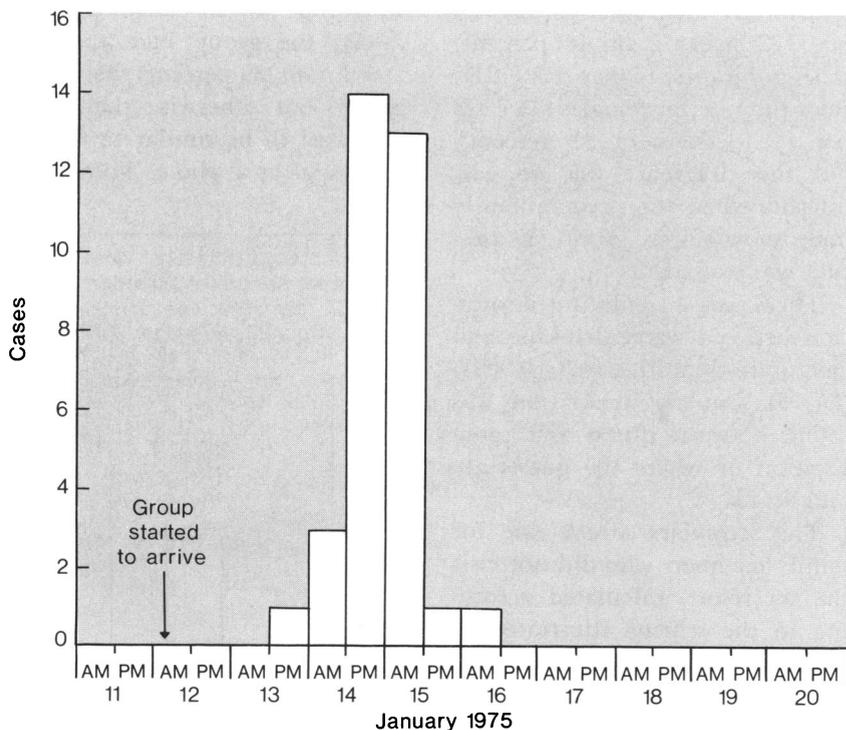


Figure 5. Gastrointestinal illness in 33 of 37-member snow surveyors ski group, by time of day and date of onset, January 1975



of the 37 snow surveyors were men. The median interval between arrival at the resort and onset of illness was 50 hours (fig. 4). The association between water consumption and gastrointestinal illness was again demonstrated:

Health status	Snow surveyors consuming daily—	
	4 glasses or fewer ¹	More than 4 glasses ¹
Ill	6	27
Well	4	0

¹ Of water and iced beverages.

NOTE: Fisher's 2-tail test $P = 0.003$.

No association was found between illness and consumption of specific food items.

Water System

We examined the plans of the water system at the resort in detail and inspected it where possible. Because of heavy snow, we could not inspect the wells. The water

supply to the lodge and approximately 200 condominiums in the surrounding area comes from two 60-foot-deep wells that are finished in sand and gravel and have 0.040-inch slot screens. The wells produce 80 to 210 gallons per minute and have submersible pumps, properly installed with sanitary well seals. Water is pumped to a common line that empties into a 17,000-gallon suction well supplying two high-pressure service pumps. The service pumps draw water from the suction well and pump it at 105 psi to the distribution system and to a 500,000-gallon storage tank. A third well had not functioned since October 1974 because of a broken power cable. Water was neither disinfected nor filtered before January 17, 1975.

The water supply is tested routinely every 1 to 2 months by the Montana State Department of

Health and Environmental Sciences, and from March 1972 through November 18, 1974, the tests revealed no coliform contamination. No sample was collected in December 1974.

From the two wells in use, we collected daily approximately 4 liters of water January 28, 30, and 31 and February 1, 2, and 3, 1975. These water samples were processed through membrane filters, which were cultured on M Endo medium at 35° C for 48 hours and then held at room temperature for several days. Representative bacterial colonies were identified according to conventional bacteriological methods.

In samples collected on January 28 through February 3, a total of 85 colonies were recovered from 2 liters of water from well No. 1 and 69 colonies were recovered from the same amount of water from well No. 2. A total of 15 representative isolates of the predominant growth, all from well No. 2, were identified as *Y. enterocolitica*. The number of coliform organisms found in each 250-ml sample from well No. 2 and the dates of the sample collections were as follows:

January 28	7
January 30	0
January 31	1
February 1:	
Morning	0
Afternoon	1
February 2:	
Morning	1
Afternoon	1
February 3	0
Total	11

No coliform organisms were found in the samples taken on these same dates from well No. 1. However, *Aeromonas* and *Citrobacter* species were present in samples from both wells. Several isolates did not conform to commonly recognized patterns and were not identified.

On February 26, 1975, five 1-liter samples were obtained from well No. 2 and four from well No. 1 and were processed in the manner just described. *Y. enterocolitica* was recovered from the water from both wells. However, the majority of the gram-negative isolates from the water samples collected at this time were of the *Aeromonas* species. A few *Enterobacter* organisms were also recovered.

Approximately 2 liters of water were collected on February 26 from the dead-end outlets of the water distribution system, some of which had not been opened since the outbreak. No *Y. enterocolitica* or coliforms were isolated from this water.

The *Y. enterocolitica* organisms isolated from wells Nos. 1 and 2 were Nilehn (4) biotype 1. All 19 isolates were screened for antibiotic resistance. Five strains were resistant to ampicillin and nine to cephalothin. Fourteen isolates were also serotyped against rabbit serums hyperimmunized for 34 "0" factors. Three were rough; five were smooth nontypable; two were serotype 0:4,33; one was serotype 0:18,28; another was serotype 0:3; the last was serotype 0:5.

Engineering plans of the water system showed a large sewer line near wells Nos. 1 and 2; however, dye studies showed no evidence of any cross connections between these two wells and the sewerage system. Rhodamine dye was continuously injected into the sewerage system for 5 days in February 1975, and well-water samples were subsequently examined with a Turner fluorometer. A second sewage line was similarly treated with sodium fluorescein for 2 weeks in February. None of the well-water samples showed any fluorescence. Although no leaks or cross connections were demon-

strated, we believe that the extremely low temperatures prevalent at the time might have sealed leaks in the sewage line by freezing, thus making it impossible to locate the contamination source.

Wells at the ski resort and in the surrounding area were sampled again on June 16, 17, and 18, 1975; *Y. enterocolitica* was still present in wells Nos. 1 and 2 but was not recovered from 18 other wells and springs at the resort and in the surrounding area. Repeat dye studies evidenced no cross connections between wells Nos. 1 and 2 and the sewerage system.

Laboratory Studies

Stool cultures. Stool samples from seven acutely ill patients were cultured during the epidemic period by private physicians. No salmonellae or shigellae were found according to the physicians' reports.

After *Y. enterocolitica* had been isolated from the well water, we obtained rectal swabs or stool specimens on February 26 and 27 from 81 resort employees and 104 residents of Billings, Mont., who had visited the resort during the epidemic period or were members of the families of such visitors. Of these 185 persons, 100 (54 percent) had had a gastrointestinal illness. All stool and rectal swabs from the 185 persons were placed in phosphate-buffered saline (pH 7.6) and refrigerated at 4° C. At 3 days and again at 17 days, each specimen was inoculated onto SS agar and MacConkey's agar and incubated at 22° C for 48 hours; plates were then screened for *Y. enterocolitica*. None of the 185 rectal swabs or stool specimens yielded *Y. enterocolitica*.

Serum specimens. Serum specimens collected from the ill em-

ployees 2 to 6 weeks after their illness occurred were tested against antigen prepared with the serotype 5 strain and found negative. This strain was selected because it was rhamnose-negative and was of a serotype previously associated with human illness. The other strains (0:3; 0:18,28; and 0:4,33) were not tested. All were rhamnose-positive.

Discussion

The identification of 129 cases of an acute gastrointestinal illness in the sample survey probably means that the true number of cases approached 750, since approximately 1,550 guests had stayed at the lodge during the epidemic period and there were approximately 350 employees at the resort. This figure does not include people who stayed in condominiums or who did not stay overnight at the ski resort. Although the exact source of contamination was not located, the investigators recommended that chlorination of the water system be continued and that wells Nos. 1 and 2 be relocated to comply with State regulations pertaining to public water systems.

The role of *Y. enterocolitica* in this outbreak is not clear. The organism has been linked to human illness in this country (5, 6), but the number of cases is small and the epidemiology poorly defined. An animal reservoir has been documented (7), and some cases have been linked to animal exposure (5).

Gastrointestinal symptoms are common manifestations of the disease. In Japan, two large community outbreaks of gastrointestinal illness have been described by Asakawa (3); the symptoms manifested in these outbreaks are shown in the table (Study 1 and Study 2). There was strong bacteriological evidence to implicate *Y.*

enterocolitica as the causative organism in the outbreaks, but no source was identified. Other syndromes associated with *Y. enterocolitica* infection include septicemia (6,8), polyarthritis (9) erythema nodosum (9), and pharyngitis (5).

The significance of the isolation of *Y. enterocolitica* from water is also unclear. In Norway, 10 of 50 randomly sampled water specimens were positive for *Y. enterocolitica* (10), but no disease was associated with these isolations. In this country, sporadic cases have been linked to contaminated water (6), but no large waterborne outbreaks have been documented. There are no published data on the prevalence of *Y. enterocolitica* in chlorinated and unchlorinated water supplies at the time of the outbreak.

A plausible explanation for the infrequent identification of *Y. enterocolitica* as a pathogen is the organism's growth characteristics. It can be confused with other coliforms when routine isolation measures are used. Cold enrichment of rectal swabs in phosphate-buffered saline, followed by incubation on primary plating media at 22–25° C, is useful in isolating *Y. enterocolitica*, but this is not a routine procedure in most laboratories.

In the Montana outbreak, our failure to isolate the organism

Clinical manifestations of *Yersinia enterocolitica* enteritis

Symptom	Percent of study subjects with symptom ¹			
	Study 1 ² in Japan	Study 2 ² in Japan	Study in North Carolina ³	Ski resort in Montana
Abdominal pain	86	64	62	62
Fever	76	50	87	36
Diarrhea	60	32	69	71
Nausea	24	24	.....	81
Vomiting	4	11	56	61
Headache .....	.....	.....	18	41
Malaise .....	.....	.....	.....	49
Pharyngitis .....	.....	.....	31	.....

¹ Leaders (...) indicate symptoms not reported in study.

² Reference 3.

³ Reference 5.

from previously ill persons precludes our attributing the outbreak to waterborne yersiniosis. The long interval between illness and specimen collection (4 to 7 weeks) may partially explain this failure. The stool specimens collected by private physicians during the epidemic period were not tested for *Y. enterocolitica* because this pathogen was not suspected at that time.

Further study is needed to determine the prevalence of *Y. enterocolitica* in water supplies, in persons with diarrheal illness, and in healthy controls.

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SYNOPSIS

EDEN, KENNETH V. (Center for Disease Control), ROSENBERG, MARK L., STOOPLER, MARK, WOOD, BRUCE T., HIGHSMITH, ANITA K., SKALIY, PETER, WELLS, JOY G., and FEELEY, JAMES C.: *Waterborne gastrointestinal illness at a ski resort. Isolation of Yersinia enterocolitica from drinking water. Public Health*

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Approximately 41 percent of the visitors and employees who were at a ski resort in Montana between December 23, 1974, and January 17, 1975, became ill with diarrhea and other gastrointestinal symptoms. The association between illness and water consumption proved to be signifi-

cant, and the previously noncontaminated water supply was found to contain coliforms. No pathogens except *Yersinia enterocolitica* were isolated, and it was isolated from two wells serving the area. The role of *Y. enterocolitica* in this outbreak is not clear, but it was the only organism isolated that is known to be pathogenic.